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RELATION BETWEEN MOISTURE CONTENT OF FINE FUELS AND RELATIVE HUMIDITY

By

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Measurements indicate a relation between diurnal curves of relative humidity and moisture content of some important fuels of Oregon and Washington. Some of these measurements were made in early years of forest fire research in this region.[1/] [2/] The data in this note were collected at intervals throughout 4 days (in September 1938) at the Wind River Experimental Forest near Carson, Wash. The relations presented here will be of interest when the new National Fire Danger Rating System is used in the Pacific Northwest. This system bases its estimate of fine-fuel moisture content on relative humidity measurements.

Experience has shown that forest fires burn more readily as fuel moisture decreases. Relation of moisture content to relative humidity has been used for years in forest fire control. This note illustrates how that relation affected moisture content of fine fuels on several days in one locality in the Pacific Northwest.

[1/] Hofmann, J. V., and Osborne, Wm. B., Jr. Relative humidity and forest fires. U.S. Forest Serv., 16 pp. [unnumbered], illus. 1923.

[2/] Simson, A. Gael. Relative humidity and short-period fluctuations in the moisture content of certain forest fuels. Monthly Weather Rev. 58(9): 373-374. 1930.

METHOD OF STUDY

Relative humidity and the moisture content of more than 100 samples of fine fuels were simultaneously measured. Measurements began in early morning and continued until late evening. The fuels were: (1) fine screenings of reddish rotten wood from the decayed surface of Douglas-fir (Pseudotsuga menziesii) logs; (2) duff (screened through a 1/4-inch mesh), with no covering of twig litter, from an overmature stand of Douglas-fir and western hemlock (Tsuga heterophylla); (3) dead needles from the top layer of ponderosa pine (Pinus ponderosa) litter; (4) dead cheatgrass (Bromus tectorum) from the previous growing season; and (5) dead western bracken (Pteridium aquilinum var. pubescens) from the previous growing season. These are common fuels in the Pacific Northwest.

The rotten wood and duff were spread in shallow metal pans. The cheatgrass, pine needles, and bracken were spread on trays. During the test period, the fuels were exposed on the ground in a sunny location.

Moisture content of only the very top layer of these fuels was measured by the ovendry weight method. During the tests, a hygrothermograph (in a white wooden shelter on the ground) recorded both temperature and relative humidity within 20 feet of the fuels (fig. 1).

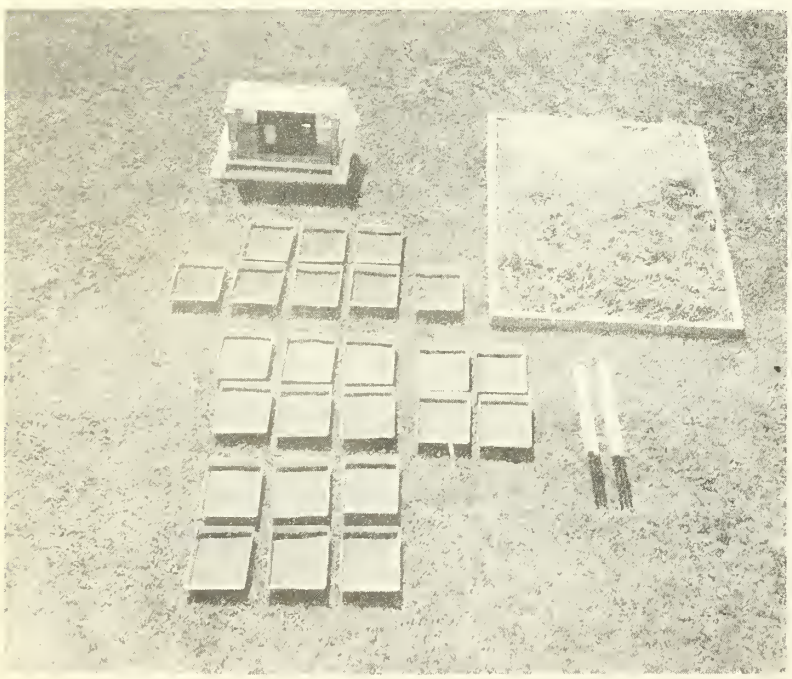

Figure 1.--Rotten wood and duff in the pans. Ponderosa pine needles on the screen. A hygrothermograph in a wooden shelter at the upper left.

RESULTS

Relative humidity and moisture contents of fine fuels are compared in figures 2 and 3. The patterns of moisture content and humidity are similar. Even the sudden change in humidity at 1330 hours (caused by passing clouds) on September 9 was accompanied by a like change in fuel moisture. Although the trend of fuel moisture closely followed humidity, the fuel moisture that accompanied a given humidity varied. This variation was greatest when the humidity was falling or rising. The relation between relative humidity and fuel moisture is more consistent in the afternoon than in the morning.

Since fine fuels have a great surface area compared with their volume, such quick responses to changes in atmospheric moisture could be expected. Bracken usually had the highest moisture content. During midday, cheatgrass (the most responsive) and rotten wood had the lowest moisture content. Pine needles and duff showed less response to humidity change. Excluding bracken, whenever the humidity was below 50 percent, fine-fuel moisture was nearly always less than 10 percent. When the humidity was about 30 percent, fine-fuel moisture was about 5 percent.

DISCUSSION

At many locations in Oregon and Washington, diurnal changes in humidity, similar to those in figures 2 and 3, will probably be accompanied by fuel-moisture trends similar to those shown. It is likely that heavy nighttime dew occurred at Wind River during the sampling period. Patterns of fuel moisture at stations where no dew forms will probably differ from those at Wind River (particularly in the morning hours) even though daytime relative humidity patterns are similar. Differences in temperature and amount of sunshine at various stations may cause somewhat different fuel moisture patterns for relative humidities like those shown in figures 2 and 3. Since humidity was measured only a few inches above the ground for these tests, relations between fuel moisture and humidity measured at 4 to 5 feet will be different.

Diurnal humidity changes consistently affected moisture content of the fine forest fuels tested. Moisture content of these fine fuels may be predicted when trends and values of relative humidity are similar to those in figures 2 and 3. Probability of ignition of such fuels from certain causes may be determined more objectively

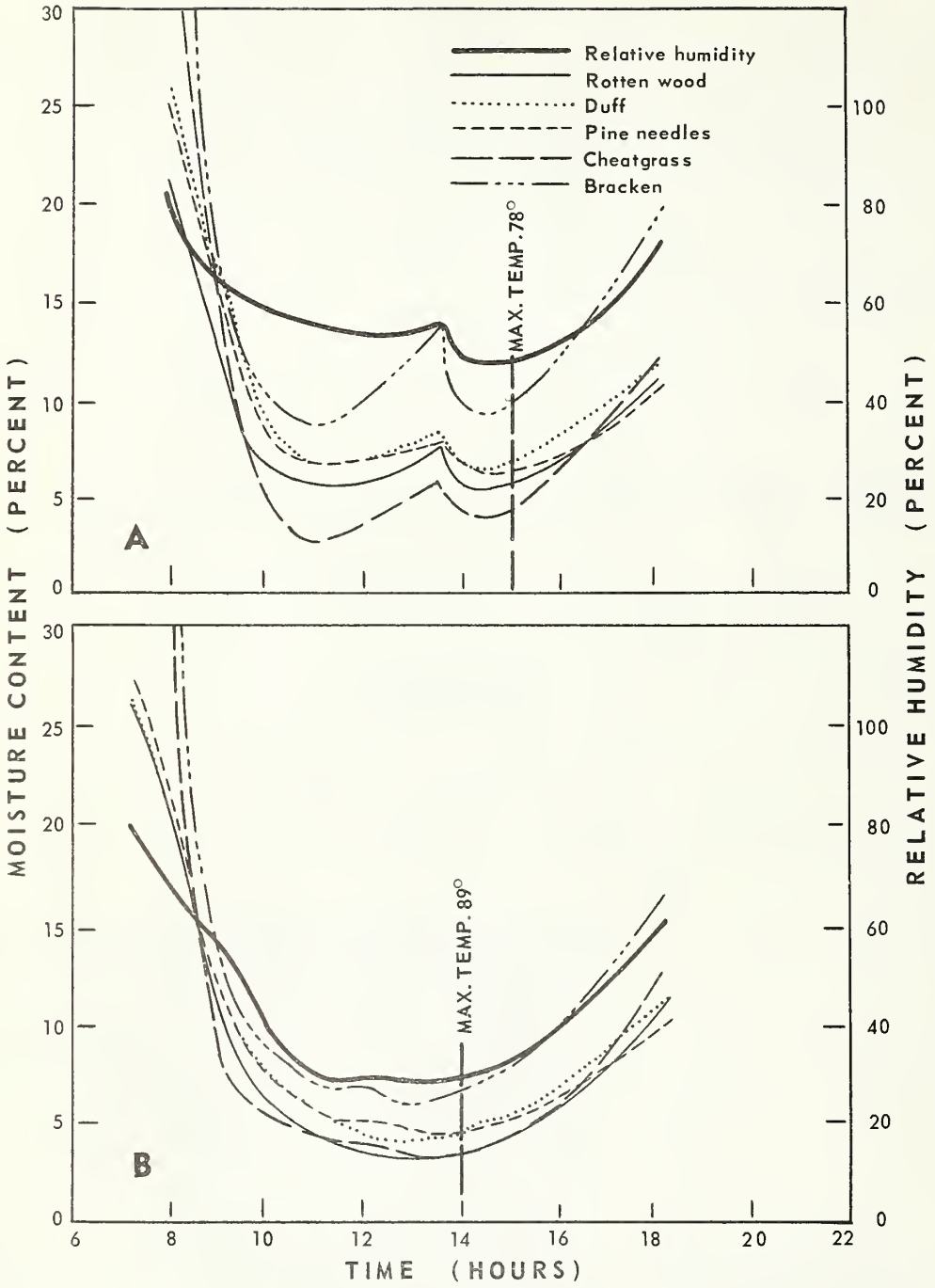

Figure 2.--Relation between relative humidity and the moisture content of some fine fuels on September 9 (A) and September 12 (B).

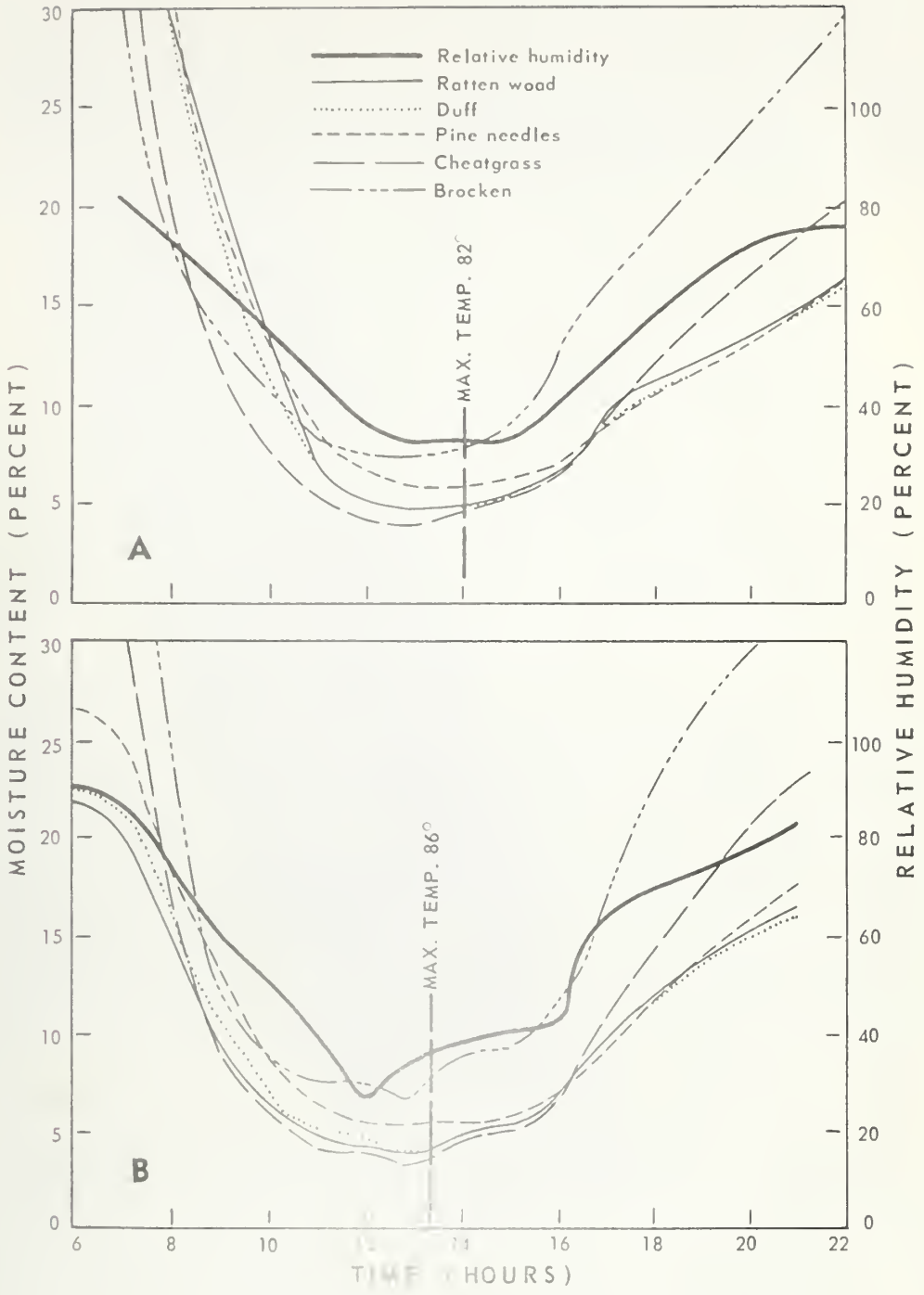

Figure 3.--Relation between relative humidity and the moisture content of some fine fuels on September 20 (A) and September 21 (B).

with the aid of the relations shown in this note. Exact estimates of moisture content of fine fuels depend not only on current humidity, but also on amount of moisture absorbed during the night and on solar radiation reaching the fuel. On the west slopes of the Cascade Range of southern Washington and in other localities with weather similar to the study area, the relations shown in this note can be used to estimate the moisture content of fine fuels.